gold nuclei of the required character, the criteria being the size and number of nuclei, growth is induced by a reaction between the gold in solution and a reductant that does not easily initiate nucleation. The control parameters now include temperature and the concentration of gold in solution but two other factors have overriding influence. The first is the relationship between the number of nuclei present and the amount of available gold in solution. This determines the ultimate size of the gold particles. The second factor is the reductant used, and this can determine the shape and characteristics of the gold powder.

The relationship between the number of nuclei and the amount of gold available for subsequent deposition on the nuclei is simple. For a given quantity of gold the weight of each particle is proportional to the number of nuclei. The number of nuclei is reproducible by the control of temperature and concentration of reactants, and the rate of dispersion of the nucleating reductant. A typical result of the approach is shown in Figure 2, which is a scanning electron micrograph of a gold powder with a narrow particle size range similar to the plot A in Figure 3. In this powder virtually all the particles are between 0.6 and 1.0 μm.

If more than one nucleation stage is carried out, while the growth of particles on existing nuclei is continued, then a very powerful control over particle size characteristics is exercised. By changing the number of nucleation steps, and their times during the precipitation of the powder, many variations on particle size distribution are possible. Plot D is of a distribution similar to plot A, but with a much wider size range. Staggering the nucleation steps produces skewed distributions such as those of B and C. An example of a gold powder made by using more than one nucleation stage is shown in Figure 4. The scanning electron micrograph, Figure 5, shows a typical gold powder produced by a method in which nucleation and growth were not controlled.

The shape characteristics of gold powder fall into two categories. The gold powder particles can be almost entirely spherical. The reductants that produce spherical particles include sulphur dioxide, sulphites and related compounds.

Alternatively the gold powder has particles that show a well defined crystallinity. This situation arises from the use of reductants covering a wide range of chemical constitution (1, 2, 3, 4).

It is clear then that the technology, upon which the preparation of a number of styles of gold powder that are important in industrial applications rests, is now at a high stage of development. As a result it is a relatively simple matter to produce gold powders, in a reproducible manner, that span a wide range of particle size distributions and fit into the broad divisions formed by spherical particle habit and flat crystalline particles.

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Ultra-high Vacuum Seal for Stratospheric Sampler

COLD WELDED GOLD TUBE PROVIDES COMPLETE RELIABILITY

When the reliability of equipment is of paramount importance it is frequently found that the unique properties of gold result in it being utilised for the construction of the most critical components. An interesting application for gold tube, which makes full use of the corrosion resistance, ductility and weldability of the material has recently been reported by a group of workers at the Aeronomy Laboratory, NOAA Environmental Research Laboratories, Boulder, Colorado (*Rev. Sci. Instrum.*, 1976, **47**, (12), 1479).

In order to collect samples of the stratosphere for analysis of chlorocarbons and other minor constituents an all-metal sampling system, which is carried aloft by a balloon and recovered by parachute, has been developed. Prior to flight the spherical sampling containers are baked out and evacuated in the laboratory by an ultrahigh vacuum pumping unit before being sealed, which is done by pinching off a short length of high purity gold tubing with an external diameter of 6·35 mm and internal diameter 4·76 mm. Gold is an ideal material for this purpose being capable of withstanding both the high temperature required during the baking and evacuation stage in the laboratory and also the low temperature, about 200 K, encountered in the stratosphere. Even after such extremes the surface of the gold is still free from tarnish and oxidation and capable of being deformed and welded together by the modest forces available in such a lightweight system.

During the sampling and recovery stage of the flight, as the equipment descends by parachute, on-board electronic controls open the sampling container causing it to fill with air from a pre-selected altitude and then a sealing mechanism is activated. The sealing operation is again carried out on a section of gold tube which is closed off by an electrically fired explosive slug driving a wedge shaped bullet against one side of the tube while the other is constrained by a hardened anvil. As the inner surface of the gold tube is cold welded at the pinch-off a reliable seal is formed, and this is protected during the critical landing stage by the hardened tool steel bullet.